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(54) COHERENT POPULATION TRAPPING-BASED FREQUENCY STANDARD AND METHOD FOR GENERATING A FREQUENCY STANDARD INCORPORATING A QUANTUM ABSORBER THAT GENERATES THE CPT STATE WITH HIGH FREQUENCY

(75) Inventor: Miao Zhu, Palo Alto, CA (US)

(73) Assignee: Agilent Technologies, Inc., Palo Alto, CA (US)

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372/28

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Primary Examiner—Leon Scott, Jr.

(74) Attorney, Agent, or Firm—Ian Hardcastle

## (57) ABSTRACT

The frequency standard comprises a quantum absorber, source of incident electro-magnetic radiation, detector, controller and signal output. The quantum absorber has a transition between a lower quantum state split by hyperfine interaction into two lower sub-state groups of at least one lower sub-state, and an upper quantum state split by hyperfine interaction into upper sub-state groups of at least one upper sub-state. None of the upper sub-state groups is a cycling transition sub-state group having at least one allowed electric dipole transition to one lower sub-state group but none to the other. The upper quantum state differs in energy from a first lower sub-state in one of the lower sub-state groups and from a second lower sub-state in the other of the lower sub-state groups by energy differences that correspond to frequencies of  $\omega_1$  and  $\omega_2$ , respectively. The source is arranged to irradiate the quantum absorber with the incident electro-magnetic radiation that includes two main frequency components having frequencies equal to  $\omega_1$  and  $\omega_2$ . The detector generates a detection signal in response to electromagnetic radiation from the quantum absorber. The controller is responsive to the detection signal and controls the source to generate the main frequency components with a frequency difference that obtains an extremum in the detection signal. The extremum indicates that the frequency difference corresponds to an energy difference between the first and second lower sub-states. The signal output provides a frequency standard signal related in frequency to the frequency difference.

20 Claims, 5 Drawing Sheets

